1. a) If load resistor shorts, \( +12 \text{ V} \) → 100 \( \Omega \),

there's a current path through the 100 \( \Omega \) resistor to ground, so

\[
I = \frac{12 \text{ V}}{100 \Omega} = 0.12 \text{ A} \quad \text{(12 V)} = 1.4 \text{ W} > \frac{1}{4} \text{ W}
\]

so the resistor will be damaged.

b) If load resistor removed, \( +12 \text{ V} \) → 100 \( \Omega \),

Since Zener diode in reverse breakdown, there's 5.1 \( \text{ V} \) across Zener \( \Rightarrow 12 - 5.1 = 6.9 \text{ V} \) across \( R \)

so current \( I = \frac{6.9 \text{ V}}{100 \Omega} = 0.069 \text{ A} \) through \( R \) + diode

so power dissipated in \( R \) = \( \frac{6.9 \text{ V}}{100 \Omega} \) = 0.48 \( \text{ W} \) > \( \frac{1}{4} \text{ W} \).

in diode = \( \frac{6.9 \text{ V}}{0.069 \text{ A}} \) (5.1 \( \text{ V} \)) = 0.35 \( \text{ W} \) > \( \frac{1}{4} \text{ W} \).

both the resistor and the diode will be damaged.

Actually, even with \( R_L \) in place, \( V_R = 12 - 5.1 = 6.9 \text{ V} \)
so the 100 \( \Omega \) resistor will dissipate \( > \frac{1}{4} \text{ W} \) regardless.

2. a) Full-wave bridge rectifier for AC line voltage \( \Rightarrow 5 \text{ V DC with less than 0.1 V ripple into } R_L = 180 \Omega \)

\[ \text{want 5 V here}; \text{ to get this, need } 5 + 1.2 = 6.2 \text{ V peak from transformer}
\]

corresponds to \( V_{rms} = \frac{V_{pe}}{\sqrt{2}} \approx 4.4 \text{ V, rms transformer} \)

\[ \text{to keep ripple } \Delta V_r < 0.1 \text{ V}, \]

\[ \Delta V_r \approx \frac{V_{pe}(\text{avg})}{R_C} \quad \text{, } V_{pe}(\text{avg}) \approx 5 \text{ V, } f = 2(60 \text{ Hz}) = 120 \text{ Hz}, \]

\[ R = 180 \Omega \]

\[ C = \frac{V_{pe}}{fR \Delta V} = \frac{5 \text{ V}}{(120 \Omega)(180 \Omega)(0.1 \text{ V})} = 2.3 \text{ mF} = 2800 \mu\text{F} \]

b) Voltage regulator added (Zener in series with current-limiting \( R \) in parallel with \( C \)):

\[ 5 \text{ V} \]

Would want transformer \( V_{rms} \approx 4.5 \text{ V} \)

so \( V \) from rectifier always \( > 5 \text{ V} \) so Zener always on.